Single and Multiple Photoionization of Atomic Nitrogen

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Cross sections for the single, double, and triple photoionization of atomic nitrogen were determined for photon energies close to the nitrogen K-edge (390 eV - 480 eV). Measurements were performed at beamline 8.0 of the ALS with a resolution of 60 meV. A target of atomic nitrogen was obtained from the dissociation of N_2 using a microwave-driven discharge and the different charge states produced were selected with a magnetic mass analyser. The range of applications of the data obtained is wide, going from atmospheric studies and astrophysics to surface and cluster physics.

For example, the calibration of the *Advanced X-Ray Astrophysics Facility* (AXAF) depends on inner-shell photoabsorption cross sections for several targets, including atomic nitrogen. It must be underlined that the data tabulations largely used by astronomers for nitrogen threshold energies and cross sections, e.g. Henke et al. [1], are based on measurements in molecules and solids, not in atomic nitrogen in the gas phase. Our measurements showed that strong resonant features: (i) dominate the photoionization cross sections in the K-edge energy region, (ii) are quite different in atomic and molecular nitrogen, and (iii) are not evident in the available data tabulations.

The K-shell energy spectra of atoms are modified when they combine to form molecules or are adsorbed on surfaces. For example, the adsorption to different regions of the same surface can lead to different shifts in the K- shell energy levels of the atoms. This feature of adsorbed atoms was recently used as the key to a study of the influence of surface topology on the dissociation of NO molecules [2]. This kind of probe of structural sensitivity of surface reactions is fundamental to the study of heterogeneous catalysis. Although this technique is concerned with shifts in the K-shell energy spectrum of atomic nitrogen, prior to our measurements, there were no experimental results on photoionization spectroscopy of atomic nitrogen at the K-edge and higher energies, nor *ab initio* calculations. High-resolution spectroscopic data on atomic nitrogen can help in extracting quantitative information from these measurements, as well as serve as an important reference for a systematic study of the interaction between nitrogen atoms and different surfaces.

Figure 1 shows the double photoionization cross sections of atomic and molecular nitrogen as functions of the incident photon energy near the K-edge region. The difference between the molecular K-shell ionization threshold [e.g. Ref. 1] and the N^+ $1s2s^22p^3[^5S^o]$ series limit is represented in the figure.

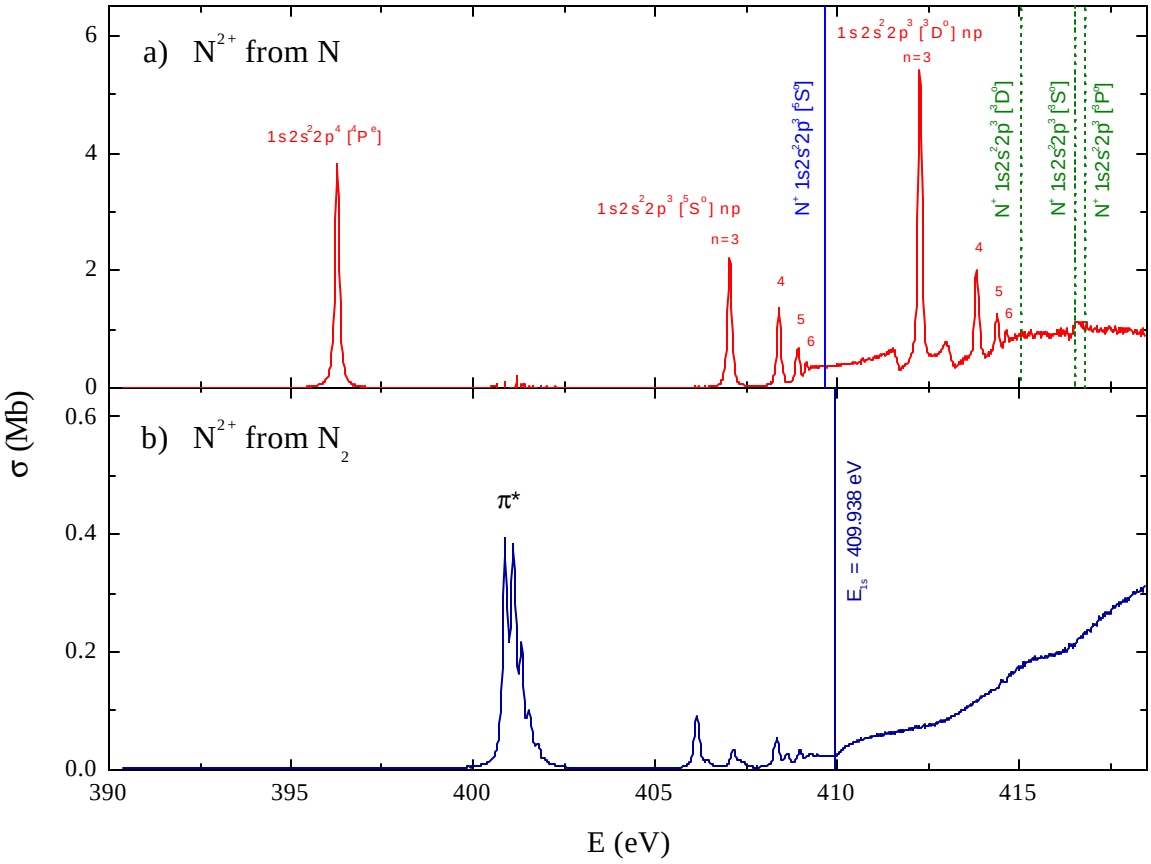

Figure 1. a) Double photoionization cross section of atomic nitrogen as a function of the incident photon energy near the K-edge region. The peak labeled $1s2s^22p^4[^4P^e]$ corresponds to the excitation of a K-shell electron from the ground state $1s^22s^22p^3[^4S^o]$ to the valence shell. The other peaks correspond to nitrogen excited states with cores $1s2s^22p^3$ [$^5S^o$, $^3D^0$, $^3S^0$, $^3P^o$] and an outer p electron. These states later decay producing nitrogen ions with different charge states. The $1s2s^22p^3[^5S^o]$ series limit was determined through the fitting of a Rydberg series to the experimental data. The other series limits (dotted lines) were obtained shifting the theoretical results of Chen *et al.* [3] by 5.831 eV, so that their value for the $1s2s^22p^3[^5S^o]$ series limit matches the experimental one. b) The double photoionization cross section of N_2, as a function of the incident photon energy, is shown for comparison. The K-shell ionization threshold is 0.301 ± 0.018 eV higher then the N^+ $1s2s^22p^3[^5S^o]$ series limit.

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